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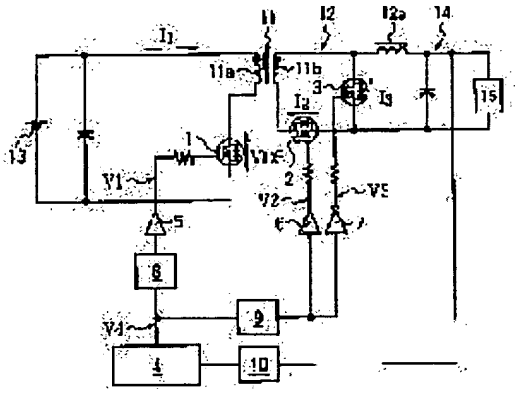
(54) SWITCHING POWER SUPPLY

(57)Abstract:

PROBLEM TO BE SOLVED: To control generation of loss and noise due to difference of the operation delay time of a switching element by providing a signal timing adjusting means so that the timing of input of the control signal to the first switching means is delayed from input of the control signal to the second and third switching means.



SOLUTION: A delay circuit 8 is arranged to the circuit between the control circuit 4 and drive circuit 5 of first switching element 1. An insulation circuit 9 connected to the drive circuits 6, 7 of the second and third switching elements 2, 3 is connected to the control circuit 4 between the control circuit 4 and delay circuit 8. The control signal V4 from the control circuit 4 is input in direct to the drive circuits 6, 78 but input to the drive circuit 5 via a delay circuit 8. When a current I3 becomes zero, the third switching element 3 turns Off to impede a terminating current of the secondary coil 11b of transformer 11. Until the time when the current I2 starts to flow, the second switching element 2 is in the ON state. Therefore, the current I2 does flow into a parasitic diode and flows only through the channel between the drain and source of the element 2.

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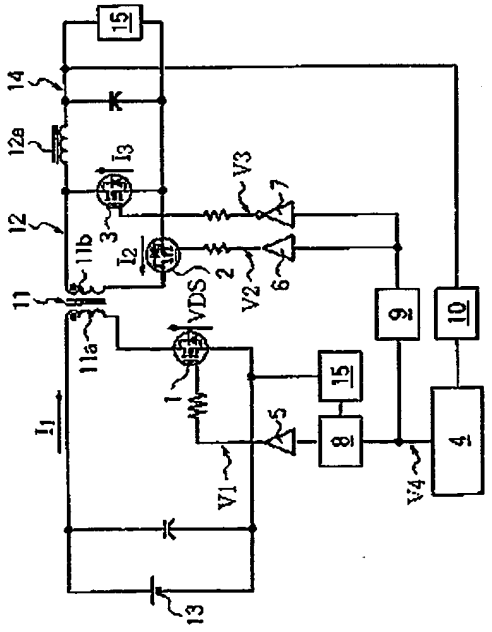
(54)【発明の名称】　スイッチング電源装置

(57)【要約】

【課題】　同期整流型スイッチング電源装置において、スイッチ回路のスイッチング素子と整流回路のスイッチング素子の作動遅れ時間の相違による損失及びノイズの発生を抑制できるスイッチング電源装置を提供すること。電源装置は、一次側のスイッチ手段と整流回路のスイッチ手段の間の耐圧特性の差に基づく作動遅れ時間の差を補償するため、該整流回路のスイッチ手段に制御信号が入力されるタイミングよりも一次側のスイッチ手段に制御信号が入力されるタイミングが遅くなるようにする信号タイミング調整手段を有する。この信号タイミング調整手段は、一次側スイッチ手段に入力される制御信号のタイミングを遅らす遅延手段として構成する。



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【特許請求の範囲】

【請求項１】　入力電圧を高周波電圧に変換する第１のスイッチ手段を有するスイッチ回路と、

前記スイッチ回路に１次巻線が接続され、２次巻線が出力回路に接続されたた変圧器と、を備え、前記出力回路は、前記変圧器の前記２次巻線に直列に接続された第２のスイッチ手段及び磁気素子と、前記２次巻線に並列に接続された第３スイッチ手段とからなる整流手段を有し、

出力電圧が所定の値となるように前記第１のスイッチ手段をオン・オフ制御するため前記第１のスイッチ手段に与えられる制御信号を形成する制御手段が設けられ、

前記第２のスイッチ手段は前記第１のスイッチ手段に与えられる制御信号と同期した前記制御手段からの信号でオン・オフ制御され、

前記第３のスイッチ手段は前記第１のスイッチ手段に与えられる制御信号とは逆のタイミングを有する前記制御手段からの信号でオン・オフ制御されるようになった、同期整流型電源装置であって、

前記第１のスイッチ手段と前記第２及び前記第３のスイッチ手段の間の耐圧特性又は電流容量の差に基づく作動遅れ時間の差を補償するため前記第２及び第３のスイッチ手段に制御信号が入力されるタイミングよりも前記第１のスイッチ手段に制御信号が入力されるタイミングが遅くなるようにする信号タイミング調整手段が設けられた、ことを特徴とする同期整流型スイッチング電源装置。

【請求項２】　請求項１に記載したスイッチング電源装置であって、前記信号タイミング調整手段は、前記第１のスイッチ手段に入力される制御信号のタイミングを遅らす遅延手段であることを特徴とするスイッチング電源装置。

【請求項３】　請求項２に記載したスイッチング電源装置であって、前記遅延手段は、前記第１スイッチ手段へのオン信号に対する遅延時間とオフ信号に対する遅延時間とを別々に設定できるようになったことを特徴とするスイッチング電源装置。

【請求項４】　請求項３に記載したスイッチング電源装置であって、負荷電流検出手段が設けられ、前記第１スイッチ手段へのオン信号に対する遅延時間が負荷電流の大きさに応じて変化させられるようになったことを特徴とするスイッチング電源装置。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】　本発明は、入力電圧をスイッチ手段によりスイッチングして高周波電圧に変換し、この高周波電圧を変圧器により変圧し、整流して任意の出力電圧を出力するスイッチング電源装置に関する。特に本発明は、出力部の整流回路の整流素子としてスイッチ手段を設け、該スイッチ手段を入力回路のスイッチ手段の

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作動と同期して作動させるようにした同期整流型スイッチング電源装置に関する。

【０００２】

【従来技術】　入力電圧をスイッチ手段により高周波電圧に変換して変圧器の１次巻線に印加し、この変圧器の２次巻線を整流回路を有する出力回路から直流出力として取り出すようにしたスイッチング電源装置はよく知られている。このスイッチング電源装置においては、整流回路は、変圧器の２次巻線に直列に接続されたダイオード等の整流素子とコイル等の磁気素子、及び、２次巻線に並列に接続され別の整流素子を備える。入力側のスイッチ手段は、出力電圧が所定の値となるように制御回路からの制御信号によりオン・オフ制御される。この形式のスイッチング電源装置において、ダイオードに固有の順方向降下電圧による損失を軽減するためにダイオードに代えてスイッチ素子を使用し、これらのスイッチ素子を入力側のスイッチ手段と同期させてオン・オフ制御するようにした構成が、同期整流型スイッチ電源装置として知られており、これらの形式のスイッチ電源装置の代表的なものは、特開平4-4750号公報、特開平5-260738号公報及び特開平7-194104号公報、並びに米国特許第4,870,555 号明細書に記載されている。

【０００３】図５に、従来の同期整流型スイッチ電源装置の一例を示す。図５において、電源１３は変圧器１１の一次巻線１１ａに接続され、該一次巻線１１ａにはさらにＦＥＴ型のスイッチ素子１が接続される。変圧器１１の二次側巻線１１ｂには、整流回路１２を有する出力回路１４が接続され、該出力回路１４は負荷１５に接続される。整流回路１２は、変圧器１１の二次巻線１１ｂに直列に接続された第２のスイッチ素子２と磁気素子すなわちインダクタ１２ａを備える。また、整流回路１２は、変圧器１１の二次巻線１１ｂに並列に接続された第３のスイッチ素子３を備える。スイッチ素子１、２、３を制御するために制御回路４が設けられている。制御回路４は、フォトカプラ又は変圧器などで構成される絶縁回路９或いは負荷電圧検出回路１０を介して出力回路１４に接続されており、出力電圧が一定になるようにパルス幅を変調した、スイッチ素子１を制御するための制御信号Ｖ４を出力する。制御回路４の出力Ｖ４は、駆動回路５を介して出力Ｖ１として第１のスイッチ素子１のゲート電極に印加される。制御回路４からの制御信号Ｖ４は又、変圧器又はフォトカプラなどで構成された絶縁回路９を介して駆動回路６、７に接続される。駆動回路６は、第１のスイッチ素子１に印加される出力Ｖ１と同じ極性の出力Ｖ２を第２のスイッチ素子２のゲート電極に印加する。駆動回路７は、第１のスイッチ素子１に印加される出力Ｖ１とは逆極性の出力Ｖ３を第３のスイッチ素子３のゲート電極に印加する。

【０００４】周知のように、制御回路４からの制御信号により第１のスイッチ素子１がオン・オフ制御されて電

源１３からの電圧を高周波電圧とし．この高周波電圧が変圧器１１の一次巻線に印加される．変圧器１１の二次巻線１１ｂに発生する電圧は整流回路１２により整流されて出力回路１４から出力される。出力回路１４の出力電圧は負荷電圧検出回路１０により検出されて制御回路４に入力される。制御回路４は、出力電圧が所定の値となるように第１のスイッチ素子１を制御するための制御信号を生成する．整流回路１２において、第１のスイッチ素子１がオン状態のときは第２のスイッチ素子２もオン状態となり．第３のスイッチ素子３はオフ状態になる。第１のスイッチ素子１がオフになると、第の２スイッチ素子２もオフになり．第３スイッチ素子３はオンになる。

【０００５】ここで、第１．第２、第３のスイッチ素子１．２、３に同じタイミングで制御信号が印加される場合には、スイッチ素子を構成するＦＥＴの作動特性のために．各スイッチ素子間で動作のタイミングにずれを生じる。すなわち．スイッチ素子のゲート電極に駆動電圧が印加されてから該スイッチ素子を流れるドレイン電流が定常値に達するまでの動作遅れ時間及びゲート電極に印加される電圧が絶たれてからドレイン電流が流れなくなるまでの動作遅れ時間がある。この遅れ時間のために．スイッチング電源装置の効率が低下する。この点を詳細に説明すると、入力側は電圧が高いために．入力側のスイッチ素子１を構成するＦＥＴは．一般に耐圧が比較的高く、電流容量の小さいものが使用される。したがって．このスイッチ素子１は、ゲート電極に駆動電圧が印加されてからオン状態となるまでの遅れ時間及び駆動電圧が除去されてからオフ状態となるまでの遅れ時間が比較的短い。これに対して．出力側は電圧が低く．出力側のスイッチ素子２、３を構成するＦＥＴは、一般に耐圧が低く電流容量の大きいものが使用される。このため．これらスイッチ素子２．３においては、ゲート電極に駆動電圧が印加されてからオン状態となるまでの遅れ時間及び駆動電圧が除去されてからオフ状態となるまでの遅れ時間が比較的長い。

【０００６】図５に示すスイッチング電源装置の各部の電圧又は電流波形を図６に示す。時刻ｔ。で制御信号Ｖ４がローからハイになると．駆動回路５からの出力Ｖ１と駆動回路６からの出力Ｖ２が同時にハイになる．また．駆動回路７からの出力Ｖ３は同じタイミングでローになる。この時刻ｔ。からスイッチング素子の作動特性に応じた遅れ時間の後、時刻ｔ，でスイッチング素子１がオンになり．電流Ｉ，が変圧器１１の一次側巻線１１ａに流れる。同時に、変圧器１１の二次側巻線１１ｂに電流Ｉ，が発生する。スイッチング素子１のオフ状態でスイッチング素子３に流れていた電流Ｉ，は、時刻ｔ，で減少し始め．時刻ｔ，でゼロになる。素子の特性上、スイッチング素子３の作動遅れ時間はスイッチング素子１の遅れ時間より長いので．この時点ではスイッチング

素子３はまだオン状態にある。したがって、変圧器１１の二次巻線１１ｂは、スイッチング素子２、３を介して短絡状態となり．大きな短絡電流が流れ、効率低下及びノイズの原因となる。また．スイッチング素子２も作動遅れ時間がスイッチング素子１よりも長いので．この時点では、スイッチング素子２はオフ状態にある。そのため．該スイッチング素子２を通って流れる短絡電流は、ドレイン・ソース間のチャンネルではなく、内部の寄生ダイオードを通ることになるので、損失が大きくなる。図６において．電流Ｉ，のうち寄生ダイオードに流れる電流を斜線で示す。

【０００７】時刻ｔ，で制御信号Ｖ４がハイからローになると、駆動回路５からの出力Ｖ１と駆動回路６からの出力Ｖ２がローになる。駆動回路の出力Ｖ３は同じタイミングでローからハイになる。時刻ｔ，からスイッチング素子の作動特性に応じた遅れ時間の後、時刻ｔ。でスイッチング素子１がオフになり、電流Ｉ，、Ｉ，が減少し始め、電流Ｉ，が増加し始める。このとき、スイッチング素子３はまだオン状態でないため．該スイッチング素子３には寄生ダイオードを通って電流が流れるようになり．損失が大きくなる。図６に、電流Ｉ，のうち、寄生ダイオードに流れる電流を斜線で示す。

【０００８】

【発明が解決しようとする課題】　本発明は、上述した形式の同期整流型スイッチング電源装置において．スイッチ回路のスイッチング素子と整流回路のスイッチング素子の作動遅れ時間の相違による損失及びノイズの発生を抑制できるスイッチング電源装置を提供することを解決すべき課題とする。

【０００９】

【課題を解決するための手段】　上記課題を解決するための本発明によるスイッチング電源装置は、入力電圧を高周波電圧に変換する第１のスイッチ手段を有するスイッチ回路と、該スイッチ回路に１次巻線が接続され、２次巻線が出力回路に接続されたた変圧器と、を備え、該出力回路は、変圧器の２次巻線に直列に接続された第２のスイッチ手段及び逆気素子と、２次巻線に並列に接続された第３スイッチ手段とからなる整流手段を有し、出力電圧が所定の値となるように第１のスイッチ手段をオン・オフ制御するため該第１のスイッチ手段に与えられる制御信号を形成する制御手段が設けられ、第２のスイッチ手段は第１のスイッチ手段に与えられる制御信号と同期した制御手段からの信号でオン・オフ制御され、第３のスイッチ手段は第１のスイッチ手段に与えられる制御信号とは逆のタイミングを有する制御手段からの信号でオン・オフ制御されるようになった．同期整流型の装置である。本発明の電源装置は、その特徴として．第１のスイッチ手段と第２及び第３のスイッチ手段の間の耐圧特性又は電流容量の差に基づく作動遅れ時間の差を補償するため第２及び第３のスイッチ手段に制御信号が入

力されるタイミングよりも第1のスイッチ手段に制御信号が入力されるタイミングが遅くなるようにする信号タイミング調整手段を有する。この信号タイミング調整手段は、第1のスイッチ手段に入力される制御信号のタイミングを遅らす遅延手段として構成することが最も望ましい。この場合、該遅延手段は、第1スイッチ手段へのオン信号に対する遅延時間とオフ信号に対する遅延時間とを別々に設定できるようにすることが好ましい。本発明のさらに好ましい態様においては、負荷電流検出手段を設け、第1スイッチ手段へのオン信号に対する遅延時間が負荷電流の大きさに応じて変化させられるようにする。

【0010】本発明のスイッチング電源装置においては、上述のように、信号タイミング調整手段により、第1のスイッチ手段と第2及び第3のスイッチ手段の間の耐圧特性の差に基づく作動遅れ時間の差を補償するため第2及び第3のスイッチ手段に制御信号が入力されるタイミングよりも第1のスイッチ手段に制御信号が入力されるタイミングが遅くなるように調整するので、第1、第2、第3スイッチング素子のオン・オフタイミングを完全に同期させることができ、スイッチング素子の寄生ダイオードに流れる電流を減少させて損失を低下させ、ノイズの発生を抑制することができる。

【0011】

【実施例】　以下、本発明の実施例を図について説明する。先ず図1を参照すると、ここに示された実施例の回路は、図5に示す従来の回路と、構成及び作用ともほぼ同一で、対応する部分は同一の符合を付して詳細な説明を省略する。この実施例の回路では、制御回路4から第1のスイッチング素子1の駆動回路5に至る回路に遅延回路8が配置される。第2、第3のスイッチング素子2、3の駆動回路6、7に後続される絶縁回路9は、制御回路4と遅延回路8の間で制御回路4に接続される。したがって、制御回路4からの制御信号V4は、駆動回路6、7には直接入力されるが、駆動回路5には遅延回路8を経て入力される。図2に、図1に示す回路の各部の電圧又は電流波形を示す。時刻t1で制御信号V4がローからハイになると、駆動回路6からの出力V2がハイになり、同時に、駆動回路7からの出力V3は同じタイミングでローになる。第1のスイッチング素子1の駆動回路5には、制御信号V4が時間ΔT1だけ遅れて入力されるので、駆動回路5の出力V1は、時刻t0より時間ΔT1だけ遅れた時刻t1でローからハイになる。スイッチング素子1は時刻t0から該スイッチング素子の動作特性に応じた遅れ時間の後、時刻t1でオンになり、電流i1が変圧器11の一次巻線11aに流れ、同時に、変圧器11の二次巻線11bに電流i2が発生する。スイッチング素子1のオフ状態でスイッチング素子3に流れていた電流i3は時刻t1で減少し始め、時刻t2でゼロになる。時刻t1では電流I1、I2も定常値に達する。スイッチング素子3は時刻t0から該スイッチング素子の作動特性に応じた遅れ時間の後、時刻t3でオフする。ΔT2は時刻t3でスイッチ素子3がオフするように定められている。一般にスイッチング素子における作動遅れ時間は、オフする時の方がオンする時間が長いので、スイッチング素子2は時刻t3よりも早い時点でオンになっている。

【0012】この回路においては、時刻t2で電流i3ゼロになるとき、第3のスイッチング素子3もオフになるので、変圧器11の二次巻線11bに短絡電流が流れるのを阻止できる。電流I2が流れ始める時刻t2までに第2のスイッチング素子2はオン状態になっているので、電流i3は素子2のドレイン・ソース間のチャンネルを流れ、寄生ダイオードには電流はほとんど流れない。このようにして、本発明のこの実施例では、損失を低減し、ノイズを減少させることができる。時刻t4で制御信号V4がハイからローになると、駆動回路6の出力V2がローになる。駆動回路の出力V3も同じタイミングでローからハイになる。第1のスイッチング素子1の駆動回路5の出力V1は、時刻t4から時間ΔT2だけ遅れた時刻t5でハイからローになる。この時刻t5からスイッチング素子の作動特性に応じた遅れ時間の後、時刻t6でスイッチング素子1がオフになり、電流i1、I1が減少し始め、電流i3が増加し始める。時間ΔT2は、第1のスイッチング素子1がオン状態からオフ状態になる場合の作動遅れ時間と第3のスイッチング素子3がオフ状態からオン状態になる場合の作動遅れ時間の差に対応するように定めてあるので、時刻t6でスイッチング素子1がオフになるときには、スイッチング素子3はすでにオン状態になっており、該スイッチング素子3には寄生ダイオードを通って電流はほとんど流れない。

【0013】一般に、スイッチング素子における作動遅れ時間は、オフする時の方がオンする時より長い。したがって、この実施例では、第2のスイッチング素子2がオフするタイミングは、時刻t6より遅れた時刻t7となる。したがって、電流I2は時刻t7までスイッチング素子2のチャンネルを流れることができ、寄生ダイオードに流れることはない。上述の実施例において、制御信号V4がローからハイになる場合の遅延回路の遅れ時間ΔT1と、制御信号V4がハイからローになる場合の遅延回路の遅れ時間ΔT2は、それぞれ別個に設定することが望ましいが、同じ値にしても相当程度の効果を達成することができる。なお、回路の構成、入力状態或いはスイッチング素子の特性によっては、制御信号V4がハイからローになる場合の遅延回路の遅れ時間ΔT2はゼロとしてもよい。

【0014】図3に本発明の他の実施例を示す。この実施例では、制御回路4は変圧器11の二次側回路内に配置されており、該制御回路4からの制御信号V4は、絶

縁回路を経ずに直接に駆動回路6、7に入力される。その他の点では、この実施例は図1の実施例と同様であり、作動も同じである。図4は、本発明のさらに別の実施例を示す。この実施例では、変圧器11の一次側回路に電流検出回路15が設けられる。この電流検出回路15は遅延回路8に接続され、出力電流の減少に応じて遅れ時間ΔT_1が大きくなり、出力電流の増加に応じて遅れ時間ΔT_1が小さくなるように遅延回路8を制御する。図1の実施例の構成では、負荷電流が減少すると、電流I_1が定常値からゼロになる時刻及び電流I_1、I_2がゼロから定常値になる時刻は、t_1より早くなり、時刻t_1に近づく。ところが、第3のスイッチング素子3がオフする時刻は、t_1のままであるので、スイッチング素子3がオン状態を継続している間にスイッチング素子1、2がオン状態になる。このため、変圧器11の二次側巻線を通る回路には、スイッチング素子2、3を介して短絡電流が流れ、ノイズ発生の原因となる。図4の実施例は、出力電流に応じて遅れ時間を制御するので、この問題を解消することができる。

【0015】本発明の構成により達成できる効率改善を特定の例について試算した。仮定として、従来の回路においては、スイッチング素子の動作遅れの違いにより、スイッチング素子の寄生ダイオードに211 nSの間電流が流れ、寄生ダイオードにおける電圧降下は0.9 Vとする。電源装置の仕様は、V_o=3.3 V、I_o=15A、駆動周波数を250 kHzとし、スイッチング素子の導通状態での抵抗値を5.7mΩとする。ダイオードで整流回路を構成した場合の効率を75%とすると、このダイオードをFET型のスイッチング素子に置き換えた整流回路を備える同期整流型スイッチング電源装置の効率は、82.9%となり、図1に示す本発明の実施例の装置の効率は83.9%になる。この計算においては、本発明により得られる効果のうち、スイッチング素子の作動遅れを補償することにより得られる効率の改善のみを考慮したものである。本発明においては、この他に、短絡電流に起因する損失の改善効果が達成され、ノイズ軽減効果も顕著である。

【0016】図7に、上述の計算に用いた仕様の回路における作動遅れ時間ΔT_2をゼロとし、ΔT_1を変化させた場合の効率の変化と、短絡電流及びリカバリ電流の変化を示す。ここで、短絡電流及びリカバリ電流は、第3のスイッチング素子3を流れる電流I_1のうち、矢印と反対方向に流れる電流を指す。この図から、遅延時間を増加させると、短絡電流が減少し、効率が約5%改善されることが分かる。この効率改善には、第2のスイッチング素子2の作動遅れの補償が寄与する部分もある。遅延時間が大きくなり過ぎると、電流I_1が流れているときに第3のスイッチング素子3がオフする状態を生じるので、電流I_1が寄生ダイオードを流れることになり、効率が低下する。寄生ダイオードに電流I_1が流れている途中で第1のスイッチング素子1がオンになると、第3のスイッチング素子3の寄生ダイオードにリカバリ電流が流れる。このリカバリ電流は遅延時間に比例して増加し、効率を悪くする原因になる。

【0017】なお、図4の実施例において、負荷電流の検出に、変圧器11の一次側回路に接続した電流検出回路15を用いたが、この電流検出回路15は、変圧器11の二次側回路に設けてもよい。

【図面の簡単な説明】

【図1】　本発明の一実施例によるスイッチング電源装置を示す回路図である。

【図2】　図1の回路における各部の電圧又は電流の波形を示す波形図である。

【図3】　本発明の他の実施例によるスイッチング電源装置を示す図1と同様な回路図である。

【図4】　本発明のさらに他の実施例によるスイッチング電源装置を示す図1と同様な回路図である。

【図5】　従来の同期整流型スイッチング電源装置の一例を示す図1と同様な回路図である。

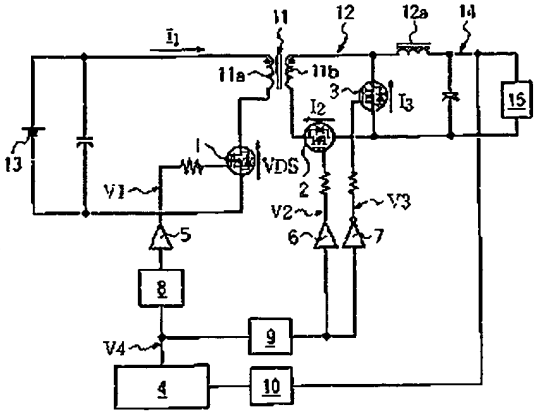
【図6】　図5の回路における各部の波形を示す図である。

【図7】　本発明に実施例における遅延時間により得られる効率の改善と短絡電流及びリカバリ電流の変化を示す図表である。

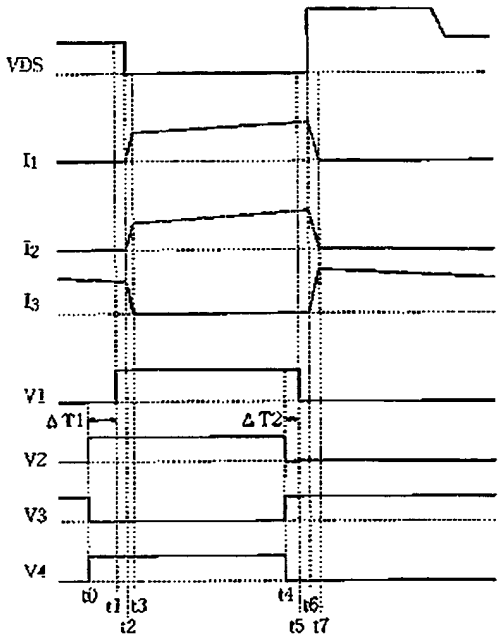
【符合の説明】

1、2、3・・・スイッチング素子、4・・・制御回路、5、6、7・・・駆動回路、8・・・遅延回路、9・・・絶縁回路、10・・・負荷電圧検出回路、11・・・変圧器、12・・・整流回路、13・・・電源、14・・・出力回路、15・・・負荷

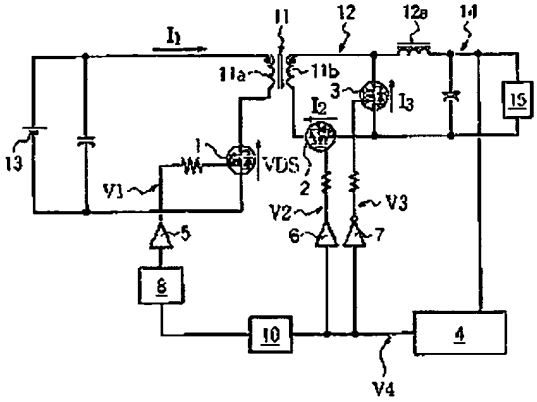
【図1】


I1
11
12
12a
14
11a
11b
3
I3
I2
15
13
1
VDS
2
V1
V2
V3
5
6
7
8
9
V4
4
10

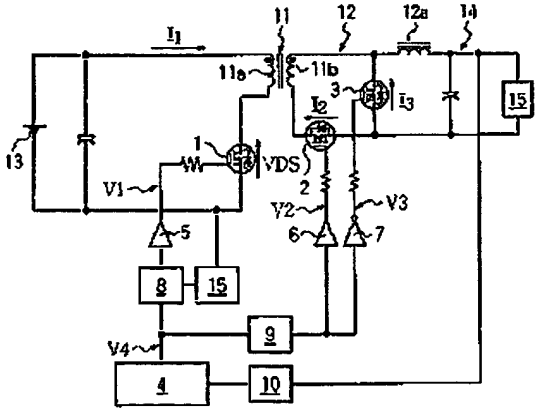
【図2】


VDS
I1
I2
I3
V1
ΔT1
ΔT2
V2
V3
V4
t0
t1
t3
t2
t4
t6
t5
t7

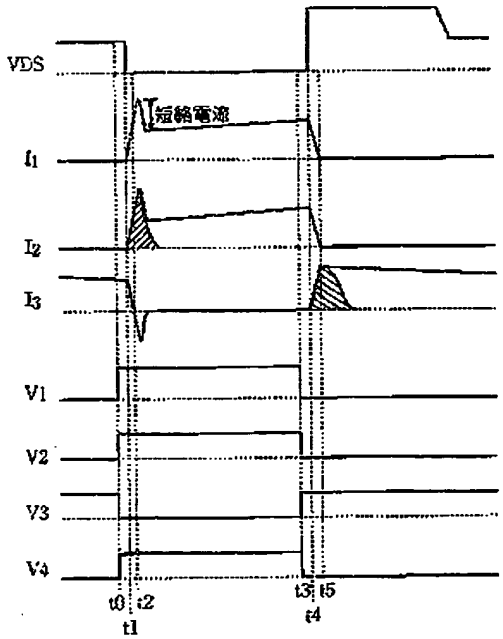
【図3】


I1
11
12
12a
14
11a
11b
3
I3
I2
15
13
1
VDS
2
V1
V2
V3
5
6
7
8
10
4
V4

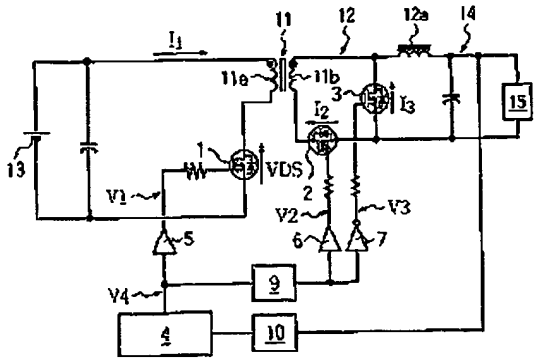
【図4】


I1
11
12
12a
14
11a
11b
3
I3
I2
15
13
1
VDS
2
V1
V2
V3
5
6
7
8
15
9
V4
4
10

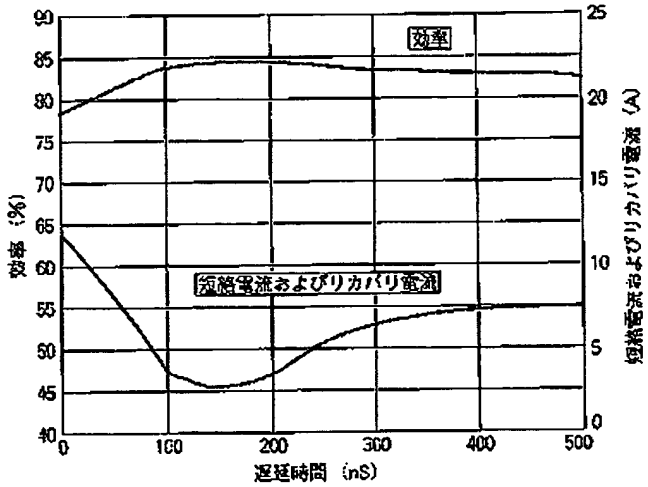
【図6】


VDS
短絡電流
I1
I2
I3
V1
V2
V3
V4
t0
t2
t1
t3
t5
t4

【図5】


11
12
12a
14
I1
11a
11b
3
I3
I2
15
13
1
VDS
V1
2
V2
V3
5
6
7
9
V4
4
10

【図7】


効率
短絡電流およびリカバリ電流
効率（%）
短絡電流およびリカバリ電流（A）
遅延時間（nS）
90
85
80
75
70
65
60
55
50
45
40
25
20
15
10
5
0
0
100
200
300
400
500

【公報種別】特許法第１７条の２の規定による補正の掲載
【部門区分】第７部門第４区分
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H02M 3/28
3/335
7/21
【Ｆ Ｉ】
H02M 3/28 F
3/335 B
7/21 A

【手続補正書】
【提出日】平成１１年１１月１６日（１９９９．１１．１６）
【手続補正１】
【補正対象書類名】明細書
【補正対象項目名】特許請求の範囲
【補正方法】変更
【補正内容】
【特許請求の範囲】
【請求項１】　入力電圧を高周波電圧に変換する第１のスイッチ手段を有するスイッチ回路と、
前記スイッチ回路に１次巻線が接続され、２次巻線が出力回路に接続された変圧器と、
を備え、前記出力回路は、前記変圧器の前記２次巻線に直列に接続された第２のスイッチ手段及び磁気素子と、前記２次巻線に並列に接続された第３スイッチ手段とからなる整流手段を有し、
出力電圧が所定の値となるように前記第１のスイッチ手段をオン・オフ制御するため前記第１のスイッチ手段に与えられる制御信号を形成する制御手段が設けられ、
前記第２のスイッチ手段は前記第１のスイッチ手段に与えられる制御信号と同期した前記制御手段からの信号でオン・オフ制御され、
同期整流型電源装置であって、
前記第１のスイッチ手段と前記第２及び第３スイッチ手段の間の耐圧特性又は電流容量の差による遅れ時間の差を補償するため前記第２及び第３スイッチ手段に制御信号が入力されるタイミングを前記第１のスイッチ手段に制御信号が入力されるタイミングより遅くなるようにする信号タイミング調整手段を設けた、ことを特徴とする同期整流型スイッチング電源装置。
【請求項２】　請求項１に記載したスイッチング電源装置であって、前記信号タイミング調整手段は、前記第１のスイッチ手段に入力される制御信号のオン信号のみを遅延させる遅延手段であることを特徴とするスイッチング電源装置。
【請求項３】　請求項２に記載したスイッチング電源装置であって、前記遅延手段は、前記第１のスイッチ手段のオン信号に対する遅延時間とオフ信号に対する遅延時間とを別々に設定できるようになったことを特徴とするスイッチング電源装置。
【請求項４】　請求項３に記載したスイッチング電源装置であって、負荷電流検出手段が設けられ、前記第１のスイッチ手段へのオン信号に対する遅延時間

Japanese Patent Application Publication No. 11-235029

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3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]

[Claim 1] A switching circuit which has the 1st switching means which changes input voltage into high-frequency voltage, It has ******** by which a primary coil was connected to said switching circuit, and a secondary coil was connected to an output circuit. Said output circuit The 2nd switching means and magnetic cell which were connected to said secondary coil of said transformer at a serial, It has a rectification means which becomes said secondary coil from the 3rd switching means connected to juxtaposition. A control means which forms a control signal given to said 1st switching means in order to carry out on-off control of said 1st switching means so that output voltage may serve as a predetermined value is established. On-off control of said 2nd switching means is carried out by signal from said control means which synchronized with a control signal given to said 1st switching means. On-off control of said 3rd switching means came to be carried out to a control signal given to said 1st switching means by signal from said control means which has timing of reverse. It is a synchronous detection mold power unit. In order to compensate a difference of an actuation time delay based on said 1st switching means, said 2nd [the] and a resisting pressure property between said 3rd switching means, or a difference of current capacity Synchronous detection mold switching telegraph-key equipment characterized by what a signal timing adjustment means to make it timing as which a control signal is inputted into said 1st switching means rather than timing as which a control signal is inputted into said 2nd and 3rd switching means become late was established for.

[Claim 2] It is switching power supply equipment characterized by being a delay means to delay the timing of a control signal of being switching power supply equipment indicated to claim 1, and inputting said signal timing adjustment means into said 1st switching means.

[Claim 3] It is switching power supply equipment characterized by the ability to set up now independently a time delay [as opposed to / are switching power supply equipment indicated to claim 2, and / an ON signal to said 1st switching means in said delay means], and a time delay over an off signal.

[Claim 4] Switching power supply equipment characterized by being switching power supply equipment indicated to claim 3, establishing a load current detection means, and coming to

change a time delay over an ON signal to said 1st switching means according to magnitude of the load current.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention switches input voltage by the switching means, changes it into high-frequency voltage, and relates to the switching power supply equipment which transforms this high-frequency voltage with a transformer, rectifies and outputs the output voltage of arbitration. Especially this invention establishes a switching means as a rectifying device of the rectifier circuit of the output section, and relates to the synchronous detection mold switching power supply equipment it was made to operate this switching means synchronizing with actuation of the switching means of an input circuit.
[0002]
[Description of the Prior Art] Input voltage is changed into high-frequency voltage by the switching means, it is impressed by the primary coil of a transformer, and the switching power supply equipment which took out the secondary coil of this transformer from the output circuit which has a rectifier circuit as a dc output is known well. In this switching power supply equipment, it connects with a rectifying device, magnetic cells, such as a coil, and secondary coils, such as diode connected to the secondary coil of a transformer at the serial, at juxtaposition, and a rectifier circuit is equipped with another rectifying device. On-off control of the switching means of an input side is carried out by the control signal from a control circuit so that output voltage may serve as a predetermined value. In the switching power supply equipment of this format, in order to mitigate loss by the forward drop voltage of a proper to diode, it replaces with diode and a switching device is used, the configuration which these switching devices are synchronized with the switching means of an input side, and was made to carry out on-off control is known as a synchronous detection mold switch power unit, and the typical thing of the switch power unit of such format is indicated by JP,4-4750,A, JP,5-260738,A and JP,7-194104,A, and the list at the U.S. Pat. No. 4,870,555 description.
[0003] An example of the conventional synchronous detection mold switch power unit is shown in drawing 5 . In drawing 5 , a power supply 13 is connected to primary-winding 11a of a transformer 11, and the switching device 1 of an FET mold is further connected to this primary-winding 11a. The output circuit 14 which has a rectifier circuit 12 is connected to secondary coil 11b of a transformer 11, and this output circuit 14 is connected to a load 15. A rectifier circuit 12 is equipped with 2nd switching device 2 and magnetic cell, i.e., inductor, 12a connected to secondary-winding 11b of a transformer 11 at the serial. Moreover, a rectifier circuit 12 is equipped with the 3rd switching device 3 connected to juxtaposition at secondary-winding 11b of a transformer 11. In order to control switching devices 1, 2, and 3, the control circuit 4 is formed. It connects with the output circuit 14 through the insulating circuit 9 or the load voltage detector 10 which consists of a photo coupler or a transformer, and a control circuit 4 outputs the control signal V4 for controlling a switching device 1 which modulated pulse width so that output voltage might become fixed. The output V4 of a control circuit 4 is impressed to the gate electrode of the 1st switching device 1 as an output V1 through the actuation circuit 5. The control signal V4 from a control circuit 4 is connected to the actuation circuits 6 and 7 again through the insulating circuit 9 which consisted of a transformer or a photo coupler. The actuation circuit 6 impresses the same polar output V2 as the output V1 impressed to the 1st switching device 1 to the gate electrode of the 2nd switching device 2. The actuation circuit 7

impresses the output V3 of reversed polarity to the gate electrode of the 3rd switching device 3 with the output V1 impressed to the 1st switching device 1.

[0004] As everyone knows, on-off control of the 1st switching device 1 is carried out by the control signal from a control circuit 4, voltage from a power supply 13 is made into high-frequency voltage, and this high-frequency voltage is impressed to the primary winding of a transformer 11. It is rectified by the rectifier circuit 12 and the voltage generated in secondary-winding 11b of a transformer 11 is outputted from an output circuit 14. The output voltage of an output circuit 14 is detected by the load voltage detector 10, and is inputted into a control circuit 4. A control circuit 4 generates the control signal for controlling the 1st switching device 1 so that output voltage serves as a predetermined value. In a rectifier circuit 12, when the 1st switching device 1 is an ON state, the 2nd switching device 2 will also be in an ON state, and the 3rd switching device 3 is turned off. If the 1st switching device 1 becomes off, the 2 switching devices 2 of ** will also become off, and the 3rd switching device 3 will be turned on.

[0005] Here, when a control signal is impressed to the same timing as the 1st, 2nd, and 3rd switching device 1, 2, and 3, a gap is produced to timing of operation between each switching device for the operational characteristic of FET which constitutes a switching device. That is, there is a time delay of operation after the voltage impressed to a time delay of operation and a gate electrode until the drain current which flows this switching device after driver voltage is impressed to the gate electrode of a switching device reaches a steady-state value is severed until drain current will not flow. The effectiveness of switching power supply equipment falls for this time delay. If this point is explained to details, since voltage of an input side is high, generally FET which constitutes the switching device 1 of an input side will have comparatively high pressure-proofing, and what has small current capacity will be used. Therefore, this switching device 1 has a comparatively short time delay after a time delay and driver voltage after driver voltage is impressed to a gate electrode until it will be in an ON state are removed until it will be in an OFF state. On the other hand, voltage of an output side is low and, generally, as for FET which constitutes the switching devices 2 and 3 of an output side, the thing with low pressure-proofing which has large current capacity is used. For this reason, in these switching devices 2 and 3, a time delay after a time delay and driver voltage after driver voltage is impressed to a gate electrode until it will be in an ON state are removed until it will be in an OFF state is comparatively long.

[0006] The voltage or the current wave form of each part of switching power supply equipment shown in drawing 5 is shown in drawing 6 . Time of day t0 If a control signal V4 becomes a high from a low, the output V1 from the actuation circuit 5 and the output V2 from the actuation circuit 6 will become a high simultaneously. Moreover, the output V3 from the actuation circuit 7 becomes a low to the same timing. this time of day t0 from -- after the time delay according to the operational characteristic of a switching element, and time of day t1 A switching element 1 is turned on and current I1 flows to upstream coil 11a of a transformer 11. Simultaneously, it is current I2 to secondary coil 11b of a transformer 11. It generates. Current I3 which was flowing to the switching element 3 by the OFF state of a switching element 1 Time of day t1 It begins to decrease and is time of day t2. It becomes zero. On the property of an element, since the actuation time delay of a switching element 3 is longer than the time delay of a switching element 1, at this event, a switching element 3 is still in an ON state. Therefore, secondary-winding 11b of a transformer 11 will be in a short circuit condition through switching elements 2 and 3, and a big short-circuit current flows and it causes degradation and a noise. Moreover, since the actuation time delay is longer than a switching element 1, at this event, a switching

element 2 also has a switching element 2 in an OFF state. Therefore, since the short-circuit current which flows through this switching element 2 will pass not along the channel between the drain sources but along internal parasitism diode, loss becomes large. It sets to drawing 6 and is current I2. A slash shows the current which flows to parasitism diode inside.
[0007] Time of day t3 If a control signal V4 becomes a low from a high, the output V1 from the actuation circuit 5 and the output V2 from the actuation circuit 6 will become a low. The output V3 of an actuation circuit becomes a high from a low to the same timing. time of day t3 from -- after the time delay according to the operational characteristic of a switching element, and time of day t4 a switching element 1 -- off -- becoming -- current I1 and I2 decreasing -- beginning -- current I3 It begins to increase. Since a switching element 3 still is not an ON state at this time, to this switching element 3, current comes to flow through parasitism diode, and loss becomes large. To drawing 6 , it is current I3. A look shows the current which flows to parasitism diode inside.
[0008]
[Problem(s) to be Solved by the Invention] This invention makes it to offer the switching power supply equipment which can control the loss by difference of the actuation time delay of the switching element of a switching circuit and the switching element of a rectifier circuit, and generating of a noise the technical problem which should be solved in the synchronous detection mold switching telegraph-key equipment of the format mentioned above.
[0009]
[Means for Solving the Problem] Switching power supply equipment by this invention for solving the above-mentioned technical problem A switching circuit which has the 1st switching means which changes input voltage into high-frequency voltage, It has ******** by which a primary coil was connected to this switching circuit, and a secondary coil was connected to an output circuit. This output circuit The 2nd switching means and magnetic cell which were connected to a secondary coil of a transformer at a serial, It has a rectification means which becomes a secondary coil from the 3rd switching means connected to juxtaposition. A control means which forms a control signal given to this 1st switching means in order to carry out on-off control of the 1st switching means so that output voltage may serve as a predetermined value is established. On-off control of the 2nd switching means is carried out by signal from a control means which synchronized with a control signal given to the 1st switching means. A control signal with which the 3rd switching means is given to the 1st switching means is equipment of a synchronous detection mold by which on-off control came to be carried out by signal from a control means which has timing of reverse. A power unit of this invention has a signal timing adjustment means to make it timing as which a control signal is inputted into the 1st switching means rather than timing as which a control signal is inputted into the 2nd and 3rd switching means become late in order to compensate a difference of an actuation time delay based on a resisting pressure property between the 1st switching means and the 2nd and 3rd switching means, or a difference of current capacity as the feature. As for this signal timing adjustment means, it is most desirable to constitute as a delay means to delay timing of a control signal inputted into the 1st switching means. In this case, as for this delay means, it is desirable to enable it to set up independently a time delay over an ON signal to the 1st switching means and a time delay over an off signal. A load current detection means is established and it is made for a time delay over an ON signal to the 1st switching means to be changed in a still more desirable mode of this invention according to magnitude of the load current.
[0010] In switching power supply equipment of this invention as mentioned above with a signal

timing adjustment means In order to compensate a difference of an actuation time delay based on a difference of a resisting pressure property between the 1st switching means and the 2nd and 3rd switching means Since it adjusts so that timing as which a control signal is inputted into the 1st switching means rather than timing as which a control signal is inputted into the 2nd and 3rd switching means may become late On--off timing of the 1st, 2nd, and 3rd switching element can be synchronized thoroughly, current which flows to parasitism diode of a switching element can be decreased, loss can be reduced, and generating of a noise can be controlled.
[0011]
[Example] Hereafter, the example of this invention is explained about drawing. If drawing 1 is referred to first, the circuit of the example shown here is almost the same as that also of the conventional circuit shown in drawing 5 , and a configuration and an operation, and a corresponding portion will attach the same agreement and will omit detailed explanation. In the circuit of this example, a delay circuit 8 is arranged in the circuit from the control circuit 4 to the actuation circuit 5 of the 1st switching element 1. The insulating circuit 9 connected to the actuation circuits 6 and 7 of the 2nd and 3rd switching element 2 and 3 is connected to a control circuit 4 between a control circuit 4 and a delay circuit 8. Therefore, although the direct input of the control signal V4 from a control circuit 4 is carried out to the actuation circuits 6 and 7, it is inputted into the actuation circuit 5 through a delay circuit 8. The voltage or the current wave form of each part of a circuit shown in drawing 2 at drawing 1 is shown. Time of day t0 If a control signal V4 becomes a high from a low, the output V2 from the actuation circuit 6 will become a high, and the output V3 from the actuation circuit 7 will become a low to the same timing simultaneously. the actuation circuit 5 of the 1st switching element 1 -- a control signal V4 -- time amount deltaT1 only -- since it is behind and is inputted -- output V1 of the actuation circuit 5 Time of day t0 Time amount deltaT1 only -- overdue time of day t1 from a low -- yes, it comes to be alike a switching element 1 -- time of day t0 from -- after the time delay according to the operating characteristic of this switching element, and time of day t2 ON -- becoming -- current I1 Primary-winding 11a of a transformer 11 flowing -- simultaneous -- secondary-winding 11b of a transformer 11 Current I2 It generates. Current I3 which was flowing to the switching element 3 by the OFF state of a switching element 1 Time of day t2 It begins to decrease and is time of day t3. It becomes zero. Time of day t3 It is current I1 and I2 then. A steady-state value is reached. a switching element 3 -- time of day to from -- after the time delay according to the operational characteristic of this switching element, and time of day t3 It turns off. **T1 Time of day t3 It is determined that a switching device 3 turns off. Since the time amount which the direction when turning off the actuation time delay in a switching element turns on is generally long, a switching element 2 is time of day t2. It is turned on when early.
[0012] It sets in this circuit and is time of day t3. Current I3 Since the 3rd switching element 3 also becomes off when becoming zero, it can prevent that a short-circuit current flows to secondary-winding 11b of a transformer 11. current I2 Time of day t2 which begins to flow by -- since the 2nd switching element 2 is turned on -- current I2 Flowing the channel between the drain sources of an element 2, to parasitism diode, current hardly flows. Thus, in this example of this invention, loss can be reduced and a noise can be decreased. Time of day t4 If a control signal V4 becomes a low from a high, the output V2 of the actuation circuit 6 will become a low. The output V3 of an actuation circuit also becomes a high from a low to the same timing. the output V1 of the actuation circuit 5 of the 1st switching element 1 -- time of day t4 from -- time amount deltaT2 only -- overdue time of day t5 yes -- since -- it becomes a low. this time of day t5 from -- after the time delay according to the operational characteristic of a switching element,

and time of day t6 a switching element 1 -- off -- becoming -- current I1 and I2 decreasing -- beginning -- current I3 It begins to increase. Time amount deltaT2 Since it has determined that it corresponds to the difference of an actuation time delay in case an actuation time delay and the 3rd switching element 3 in case the 1st switching element 1 is turned off from an ON state are turned on from an OFF state, it is time of day t6. When a switching element 1 becomes off, the switching element 3 is already turned on and current hardly flows through parasitism diode to this switching element 3.

[0013] Generally, the actuation time delay in a switching element is longer than the time of the direction when turning off turning on. Therefore, the timing which the 2nd switching element 2 turns off in this example is time of day t6. Overdue time of day t7 It becomes. therefore, current I2 -- time of day t7 up to -- the channel of a switching element 2 can be flowed and it does not flow to parasitism diode Time delay deltaT1 of a delay circuit in case a control signal V4 becomes a high from a low in an above-mentioned example Time delay deltaT2 of a delay circuit in case a control signal V4 becomes a low from a high Although selecting separately, respectively is desirable, even if it makes it the same value, the effect of a considerable degree can be attained. In addition, time delay deltaT2 of a delay circuit in case a control signal V4 becomes a low from a high depending on the configuration of a circuit, an input state, or the property of a switching element It is good also as zero.

[0014] Other examples of this invention are shown in drawing 3 . In this example, the control circuit 4 is arranged in the secondary circuit of a transformer 11, and the control signal V4 from this control circuit 4 is directly inputted into the actuation circuits 6 and 7, without passing through an insulating circuit. In respect of others, this example is the same as the example of drawing 1 , and the same is said of the actuation. Drawing 4 shows still more nearly another example of this invention. In this example, the current detector 15 is established in the upstream circuit of a transformer 11. It connects with a delay circuit 8, it responds to reduction in the output current, and this current detector 15 is a time delay deltaT1. It becomes large, it responds to the increment in the output current, and is a time delay deltaT1. A delay circuit 8 is controlled to become small. When the load current decreases with the configuration of the example of drawing 1 , it is current I3. The time of day and current I1 which become zero from a steady-state value, and I2 The time of day which becomes a steady-state value from zero is t3. It becomes early and is time of day t2. It approaches. However, the time of day which the 3rd switching element 3 turns off is t3. Since it is as, while the switching element 3 is continuing the ON state, switching elements 1 and 2 are turned on. For this reason, in the circuit which passes along the secondary coil of a transformer 11, a short-circuit current flows through switching elements 2 and 3, and it becomes the cause of noise generating in it. Since the example of drawing 4 controls a time delay according to the output current, it can solve this problem.

[0015] The trial calculation of the improvement in efficiency which can be attained by the configuration of this invention was made about the specific example. As an assumption, in the conventional circuit, the current between 211 nS(s) flows to the parasitism diode of a switching element, and the voltage drop in parasitism diode is set to 0.9 V by the difference in the delay of a switching element of operation. The specification of a power unit sets V0 =3.3 V, I0 =15A, and drive frequency to 250 kHz, and sets the resistance in the switch-on of a switching element to 5.7mohm. If effectiveness at the time of constituting a rectifier circuit from diode is made into 75%, it is FET about this diode. The effectiveness of synchronous detection mold switching power supply equipment equipped with the rectifier circuit replaced with the switching element of a mold becomes 82.9%, and the effectiveness of the equipment of the example of this

invention shown in drawing 1 becomes 83.9%. In this count, only an improvement of the effectiveness acquired by compensating the actuation delay of a switching element among the effects acquired by this invention is taken into consideration. The improvement effect of loss resulting from a short-circuit current is attained, and the noise relief effect is also remarkable in this invention.

[0016] Actuation time delay deltaT2 in the circuit of the specification used for above-mentioned count at drawing 7 It considers as zero and is deltaT1. Change of the effectiveness at the time of making it change and change of a short-circuit current and recovery current are shown. Here, a short-circuit current and recovery current are current I3 which flows the 3rd switching element 3. The current which flows to an arrow head and an opposite direction is pointed out inside. When a time delay is made to increase from this drawing, it turns out that a short-circuit current decreases and effectiveness is improved about 5%. There is also a portion which compensation of the actuation delay of the 2nd switching element 2 contributes in this improvement in efficiency. When a time delay becomes large too much, it is current I3. Since the condition that the 3rd switching element 3 turns off is produced while flowing, it is current I3. Parasitism diode will be flowed and effectiveness falls. It is current I3 to parasitism diode. If the 1st switching element 1 is turned on while flowing, recovery current will flow to the parasitism diode of the 3rd switching element 3. This recovery current increases in proportion to a time delay, and becomes the cause which worsens effectiveness.

[0017] In addition, in the example of drawing 4 , although the current detector 15 linked to the primary side circuit of a transformer 11 was used for detection of the load current, this current detector 15 may be established in the secondary circuit of a transformer 11.

TECHNICAL FIELD

[Industrial Application] This invention switches input voltage by the switching means, changes it into high-frequency voltage, and relates to the switching power supply equipment which transforms this high-frequency voltage with a transformer, rectifies and outputs the output voltage of arbitration. Especially this invention establishes a switching means as a rectifying device of the rectifier circuit of the output section, and relates to the synchronous detection mold switching power supply equipment it was made to operate this switching means synchronizing with actuation of the switching means of an input circuit.

PRIOR ART

[Description of the Prior Art] Input voltage is changed into high-frequency voltage by the switching means, it is impressed by the primary coil of a transformer, and the switching power supply equipment which took out the secondary coil of this transformer from the output circuit which has a rectifier circuit as a dc output is known well. In this switching power supply equipment, it connects with a rectifying device, magnetic cells, such as a coil, and secondary coils, such as diode connected to the secondary coil of a transformer at the serial, at juxtaposition, and a rectifier circuit is equipped with another rectifying device. On-off control of the switching means of an input side is carried out by the control signal from a control circuit so that output voltage may serve as a predetermined value. In the switching power supply equipment of this format, in order to mitigate loss by the forward drop voltage of a proper to diode, it replaces with diode and a switching device is used, the configuration which these switching devices are synchronized with the switching means of an input side, and was made to carry out on-off control is known as a synchronous detection mold switch power unit, and the typical thing of the switch power unit of such format is indicated by JP,4-4750,A, JP,5-260738,A and JP,7-194104,A, and the list at the U.S. Pat. No. 4,870,555 description.

[0003] An example of the conventional synchronous detection mold switch power unit is shown in drawing 5 . In drawing 5 , a power supply 13 is connected to primary-winding 11a of a transformer 11, and the switching device 1 of an FET mold is further connected to this primary-winding 11a. The output circuit 14 which has a rectifier circuit 12 is connected to secondary coil 11b of a transformer 11, and this output circuit 14 is connected to a load 15. A rectifier circuit 12 is equipped with 2nd switching device 2 and magnetic cell, i.e., inductor, 12a connected to secondary-winding 11b of a transformer 11 at the serial. Moreover, a rectifier circuit 12 is equipped with the 3rd switching device 3 connected to juxtaposition at secondary-winding 11b of a transformer 11. In order to control switching devices 1, 2, and 3, the control circuit 4 is formed. It connects with the output circuit 14 through the insulating circuit 9 or the load voltage detector 10 which consists of a photo coupler or a transformer, and a control circuit 4 outputs the control signal V4 for controlling a switching device 1 which modulated pulse width so that output voltage might become fixed. The output V4 of a control circuit 4 is impressed to the gate electrode of the 1st switching device 1 as an output V1 through the actuation circuit 5. The control signal V4 from a control circuit 4 is connected to the actuation circuits 6 and 7 again through the insulating circuit 9 which consisted of a transformer or a photo coupler. The actuation circuit 6 impresses the same polar output V2 as the output V1 impressed to the 1st switching device 1 to the gate electrode of the 2nd switching device 2. The actuation circuit 7 impresses the output V3 of reversed polarity to the gate electrode of the 3rd switching device 3 with the output V1 impressed to the 1st switching device 1.

[0004] As everyone knows, on-off control of the 1st switching device 1 is carried out by the control signal from a control circuit 4, voltage from a power supply 13 is made into high-frequency voltage, and this high-frequency voltage is impressed to the primary winding of a transformer 11. It is rectified by the rectifier circuit 12 and the voltage generated in secondary-winding 11b of a transformer 11 is outputted from an output circuit 14. The output voltage of an output circuit 14 is detected by the load voltage detector 10, and is inputted into a control circuit 4. A control circuit 4 generates the control signal for controlling the 1st switching device 1 so that output voltage serves as a predetermined value. In a rectifier circuit 12, when the 1st

switching device 1 is an ON state, the 2nd switching device 2 will also be in an ON state, and the 3rd switching device 3 is turned off. If the 1st switching device 1 becomes off, the 2 switching devices 2 of ** will also become off, and the 3rd switching device 3 will be turned on.
[0005] Here, when a control signal is impressed to the same timing as the 1st, 2nd, and 3rd switching device 1, 2, and 3, a gap is produced to timing of operation between each switching device for the operational characteristic of FET which constitutes a switching device. That is, there is a time delay of operation after the voltage impressed to a time delay of operation and a gate electrode until the drain current which flows this switching device after driver voltage is impressed to the gate electrode of a switching device reaches a steady-state value is severed until drain current will not flow. The effectiveness of switching power supply equipment falls for this time delay. If this point is explained to details, since voltage of an input side is high, generally FET which constitutes the switching device 1 of an input side will have comparatively high pressure-proofing, and what has small current capacity will be used. Therefore, this switching device 1 has a comparatively short time delay after a time delay and driver voltage after driver voltage is impressed to a gate electrode until it will be in an ON state are removed until it will be in an OFF state. On the other hand, voltage of an output side is low and, generally, as for FET which constitutes the switching devices 2 and 3 of an output side, the thing with low pressure-proofing which has large current capacity is used. For this reason, in these switching devices 2 and 3, a time delay after a time delay and driver voltage after driver voltage is impressed to a gate electrode until it will be in an ON state are removed until it will be in an OFF state is comparatively long.
[0006] The voltage or the current wave form of each part of switching power supply equipment shown in drawing 5 is shown in drawing 6 . Time of day t0 If a control signal V4 becomes a high from a low, the output V1 from the actuation circuit 5 and the output V2 from the actuation circuit 6 will become a high simultaneously. Moreover, the output V3 from the actuation circuit 7 becomes a low to the same timing. this time of day t0 from -- after the time delay according to the operational characteristic of a switching element, and time of day t1 A switching element 1 is turned on and current I1 flows to upstream coil 11a of a transformer 11. Simultaneously, it is current I2 to secondary coil 11b of a transformer 11. It generates. Current I3 which was flowing to the switching element 3 by the OFF state of a switching element 1 Time of day t1 It begins to decrease and is time of day t2. It becomes zero. On the property of an element, since the actuation time delay of a switching element 3 is longer than the time delay of a switching element 1, at this event, a switching element 3 is still in an ON state. Therefore, secondary-winding 11b of a transformer 11 will be in a short circuit condition through switching elements 2 and 3, and a big short-circuit current flows and it causes degradation and a noise. Moreover, since the actuation time delay is longer than a switching element 1, at this event, a switching element 2 also has a switching element 2 in an OFF state. Therefore, since the short-circuit current which flows through this switching element 2 will pass not along the channel between the drain sources but along internal parasitism diode, loss becomes large. It sets to drawing 6 and is current I2. A slash shows the current which flows to parasitism diode inside.
[0007] Time of day t3 If a control signal V4 becomes a low from a high, the output V1 from the actuation circuit 5 and the output V2 from the actuation circuit 6 will become a low. The output V3 of an actuation circuit becomes a high from a low to the same timing. time of day t3 from -- after the time delay according to the operational characteristic of a switching element, and time of day t4 a switching element 1 -- off -- becoming -- current I1 and I2 decreasing -- beginning -- current I3 It begins to increase. Since a switching element 3 still is not an ON state at this time,

to this switching element 3, current comes to flow through parasitism diode, and loss becomes large. To drawing 6 , it is current I3. A look shows the current which flows to parasitism diode inside.

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] This invention makes it to offer the switching power supply equipment which can control the loss by difference of the actuation time delay of the switching element of a switching circuit and the switching element of a rectifier circuit, and generating of a noise the technical problem which should be solved in the synchronous detection mold switching telegraph-key equipment of the format mentioned above.

MEANS

[Means for Solving the Problem] Switching power supply equipment by this invention for solving the above-mentioned technical problem A switching circuit which has the 1st switching means which changes input voltage into high-frequency voltage, It has ******** by which a primary coil was connected to this switching circuit, and a secondary coil was connected to an output circuit. This output circuit The 2nd switching means and magnetic cell which were connected to a secondary coil of a transformer at a serial, It has a rectification means which becomes a secondary coil from the 3rd switching means connected to juxtaposition. A control means which forms a control signal given to this 1st switching means in order to carry out on-off control of the 1st switching means so that output voltage may serve as a predetermined value is established. On-off control of the 2nd switching means is carried out by signal from a control means which synchronized with a control signal given to the 1st switching means. A control signal with which the 3rd switching means is given to the 1st switching means is equipment of a synchronous detection mold by which on-off control came to be carried out by signal from a control means which has timing of reverse. A power unit of this invention has a signal timing adjustment means to make it timing as which a control signal is inputted into the 1st switching means rather than timing as which a control signal is inputted into the 2nd and 3rd switching means become late in order to compensate a difference of an actuation time delay based on a resisting pressure property between the 1st switching means and the 2nd and 3rd switching means, or a difference of current capacity as the feature. As for this signal timing adjustment means, it is most desirable to constitute as a delay means to delay timing of a control signal inputted into the 1st switching means. In this case, as for this delay means, it is desirable to enable it to set up independently a time delay over an ON signal to the 1st switching means and a time delay over an off signal. A load current detection means is established and it is made for a time delay over an ON signal to the 1st switching means to be changed in a still more desirable mode of this invention according to magnitude of the load current.

[0010] In switching power supply equipment of this invention as mentioned above with a signal timing adjustment means In order to compensate a difference of an actuation time delay based on a difference of a resisting pressure property between the 1st switching means and the 2nd and 3rd switching means Since it adjusts so that timing as which a control signal is inputted into the 1st switching means rather than timing as which a control signal is inputted into the 2nd and 3rd switching means may become late On--off timing of the 1st, 2nd, and 3rd switching element can be synchronized thoroughly, current which flows to parasitism diode of a switching element can be decreased, loss can be reduced, and generating of a noise can be controlled.

EXAMPLE

[Example] Hereafter, the example of this invention is explained about drawing. If drawing 1 is referred to first, the circuit of the example shown here is almost the same as that also of the conventional circuit shown in drawing 5 , and a configuration and an operation, and a corresponding portion will attach the same agreement and will omit detailed explanation. In the circuit of this example, a delay circuit 8 is arranged in the circuit from the control circuit 4 to the actuation circuit 5 of the 1st switching element 1. The insulating circuit 9 connected to the actuation circuits 6 and 7 of the 2nd and 3rd switching element 2 and 3 is connected to a control circuit 4 between a control circuit 4 and a delay circuit 8. Therefore, although the direct input of the control signal V4 from a control circuit 4 is carried out to the actuation circuits 6 and 7, it is inputted into the actuation circuit 5 through a delay circuit 8. The voltage or the current wave form of each part of a circuit shown in drawing 2 at drawing 1 is shown. Time of day t0 If a control signal V4 becomes a high from a low, the output V2 from the actuation circuit 6 will become a high, and the output V3 from the actuation circuit 7 will become a low to the same timing simultaneously. the actuation circuit 5 of the 1st switching element 1 -- a control signal V4 -- time amount deltaT1 only -- since it is behind and is inputted -- output V1 of the actuation circuit 5 Time of day t0 Time amount deltaT1 only -- overdue time of day t1 from a low -- yes, it comes to be alike a switching element 1 -- time of day t0 from -- after the time delay according to the operating characteristic of this switching element, and time of day t2 ON -- becoming -- current I1 Primary-winding 11a of a transformer 11 flowing -- simultaneous -- secondary-winding 11b of a transformer 11 Current I2 It generates. Current I3 which was flowing to the switching element 3 by the OFF state of a switching element 1 Time of day t2 It begins to decrease and is time of day t3. It becomes zero. Time of day t3 It is current I1 and I2 then. A steady-state value is reached. a switching element 3 -- time of day to from -- after the time delay according to the operational characteristic of this switching element, and time of day t3 It turns off. **T1 Time of day t3 It is determined that a switching device 3 turns off. Since the time amount which the direction when turning off the actuation time delay in a switching element turns on is generally long, a switching element 2 is time of day t2. It is turned on when early. [0012] It sets in this circuit and is time of day t3. Current I3 Since the 3rd switching element 3 also becomes off when becoming zero, it can prevent that a short-circuit current flows to secondary-winding 11b of a transformer 11. current I2 Time of day t2 which begins to flow by -- since the 2nd switching element 2 is turned on -- current I2 Flowing the channel between the drain sources of an element 2, to parasitism diode, current hardly flows. Thus, in this example of this invention, loss can be reduced and a noise can be decreased. Time of day t4 If a control signal V4 becomes a low from a high, the output V2 of the actuation circuit 6 will become a low. The output V3 of an actuation circuit also becomes a high from a low to the same timing. the output V1 of the actuation circuit 5 of the 1st switching element 1 -- time of day t4 from -- time amount deltaT2 only -- overdue time of day t5 yes -- since -- it becomes a low. this time of day t5 from -- after the time delay according to the operational characteristic of a switching element, and time of day t6 a switching element 1 -- off -- becoming -- current I1 and I2 decreasing -- beginning -- current I3 It begins to increase. Time amount deltaT2 Since it has determined that it corresponds to the difference of an actuation time delay in case an actuation time delay and the 3rd switching element 3 in case the 1st switching element 1 is turned off from an ON state are turned on from an OFF state, it is time of day t6. When a switching element 1 becomes off, the

switching element 3 is already turned on and current hardly flows through parasitism diode to this switching element 3.
[0013] Generally, the actuation time delay in a switching element is longer than the time of the direction when turning off turning on. Therefore, the timing which the 2nd switching element 2 turns off in this example is time of day t6. Overdue time of day t7 It becomes. therefore, current I2 -- time of day t7 up to -- the channel of a switching element 2 can be flowed and it does not flow to parasitism diode Time delay deltaT1 of a delay circuit in case a control signal V4 becomes a high from a low in an above-mentioned example Time delay deltaT2 of a delay circuit in case a control signal V4 becomes a low from a high Although selecting separately, respectively is desirable, even if it makes it the same value, the effect of a considerable degree can be attained. In addition, time delay deltaT2 of a delay circuit in case a control signal V4 becomes a low from a high depending on the configuration of a circuit, an input state, or the property of a switching element It is good also as zero.
[0014] Other examples of this invention are shown in drawing 3 . In this example, the control circuit 4 is arranged in the secondary circuit of a transformer 11, and the control signal V4 from this control circuit 4 is directly inputted into the actuation circuits 6 and 7, without passing through an insulating circuit. In respect of others, this example is the same as the example of drawing 1 , and the same is said of the actuation. Drawing 4 shows still more nearly another example of this invention. In this example, the current detector 15 is established in the upstream circuit of a transformer 11. It connects with a delay circuit 8, it responds to reduction in the output current, and this current detector 15 is a time delay deltaT1. It becomes large, it responds to the increment in the output current, and is a time delay deltaT1. A delay circuit 8 is controlled to become small. When the load current decreases with the configuration of the example of drawing 1 , it is current I3. The time of day and current I1 which become zero from a steady-state value, and I2 The time of day which becomes a steady-state value from zero is t3. It becomes early and is time of day t2. It approaches. However, the time of day which the 3rd switching element 3 turns off is t3. Since it is as, while the switching element 3 is continuing the ON state, switching elements 1 and 2 are turned on. For this reason, in the circuit which passes along the secondary coil of a transformer 11, a short-circuit current flows through switching elements 2 and 3, and it becomes the cause of noise generating in it. Since the example of drawing 4 controls a time delay according to the output current, it can solve this problem.
[0015] The trial calculation of the improvement in efficiency which can be attained by the configuration of this invention was made about the specific example. As an assumption, in the conventional circuit, the current between 211 nS(s) flows to the parasitism diode of a switching element, and the voltage drop in parasitism diode is set to 0.9 V by the difference in the delay of a switching element of operation. The specification of a power unit sets V0 =3.3 V, I0 =15A, and drive frequency to 250 kHz, and sets the resistance in the switch-on of a switching element to 5.7mohm. If effectiveness at the time of constituting a rectifier circuit from diode is made into 75%, it is FET about this diode. The effectiveness of synchronous detection mold switching power supply equipment equipped with the rectifier circuit replaced with the switching element of a mold becomes 82.9%, and the effectiveness of the equipment of the example of this invention shown in drawing 1 becomes 83.9%. In this count, only an improvement of the effectiveness acquired by compensating the actuation delay of a switching element among the effects acquired by this invention is taken into consideration. The improvement effect of loss resulting from a short-circuit current is attained, and the noise relief effect is also remarkable in this invention.

[0016] Actuation time delay deltaT2 in the circuit of the specification used for above-mentioned count at drawing 7 It considers as zero and is deltaT1. Change of the effectiveness at the time of making it change and change of a short-circuit current and recovery current are shown. Here, a short-circuit current and recovery current are current I3 which flows the 3rd switching element 3. The current which flows to an arrow head and an opposite direction is pointed out inside. When a time delay is made to increase from this drawing, it turns out that a short-circuit current decreases and effectiveness is improved about 5%. There is also a portion which compensation of the actuation delay of the 2nd switching element 2 contributes in this improvement in efficiency. When a time delay becomes large too much, it is current I3. Since the condition that the 3rd switching element 3 turns off is produced while flowing, it is current I3. Parasitism diode will be flowed and effectiveness falls. It is current I3 to parasitism diode. If the 1st switching element 1 is turned on while flowing, recovery current will flow to the parasitism diode of the 3rd switching element 3. This recovery current increases in proportion to a time delay, and becomes the cause which worsens effectiveness.

[0017] In addition, in the example of drawing 4 , although the current detector 15 linked to the primary side circuit of a transformer 11 was used for detection of the load current, this current detector 15 may be established in the secondary circuit of a transformer 11.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the circuit diagram showing the switching power supply equipment by one example of this invention.
[Drawing 2] It is the wave form chart showing the voltage of each part in the circuit of drawing 1 , or the wave of current.
[Drawing 3] It is the same circuit diagram as drawing 1 which shows the switching power supply equipment by other examples of this invention.
[Drawing 4] It is the same circuit diagram as drawing 1 which shows the switching power supply equipment by the example of further others of this invention.
[Drawing 5] It is the same circuit diagram as drawing 1 which shows an example of conventional synchronous detection mold switching power supply equipment.
[Drawing 6] It is drawing showing the wave of each part in the circuit of drawing 5 .
[Drawing 7] It is the chart showing change of an improvement of the effectiveness acquired by this invention by the time delay in an example, a short-circuit current, and recovery current.
[Explanation of agreement]
1, 2, 3 [... A delay circuit, 9 / ... An insulating circuit 10 / ... A load voltage detector, 11 / ... A transformer, 12 / ... A rectifier circuit, 13 / ... A power supply, 14 / ... An output circuit, 15 / ... Load] ... A switching element, 4 ... A control circuit, 5, 6, 7 ... An actuation circuit, 8

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[Claim(s)]
[Claim 1] A switching circuit which has the 1st switching means which changes input voltage into high-frequency voltage,
******** by which a primary coil was connected to said switching circuit, and a secondary coil was connected to an output circuit,
A preparation and said output circuit have a rectification means which becomes the 2nd switching means and a magnetic cell which were connected to said secondary coil of said transformer at a serial, and said secondary coil from the 3rd switching means connected to juxtaposition,
In order to carry out on-off control of said 1st switching means so that output voltage may serve as a predetermined value, a control means which forms a control signal given to said 1st switching means is established,
On-off control of said 2nd switching means is carried out by signal from said control means which synchronized with a control signal given to said 1st switching means,
A control signal with which said 3rd switching means is given to said 1st switching means is a synchronous detection mold power unit by which on-off control came to be carried out by signal

from said control means which has timing of reverse,
Synchronous detection mold switching power supply equipment characterized by what a signal timing adjustment means to make it timing as which a control signal is inputted into said 1st switching means rather than timing as which a control signal is inputted into said 2nd and 3rd switching means in order to compensate a difference of an actuation time delay based on said 1st switching means, said 2nd [the] and a resisting pressure property between said 3rd switching means, or a difference of current capacity become late was established for.
[Claim 2] It is switching power supply equipment characterized by being a delay means to delay the timing of a control signal of being switching power supply equipment indicated to claim 1, and inputting said signal timing adjustment means into said 1st switching means.
[Claim 3] It is switching power supply equipment characterized by the ability to set up now independently a time delay [as opposed to / are switching power supply equipment indicated to claim 2, and / an ON signal to said 1st switching means in said delay means], and a time delay over an off signal.
[Claim 4] Switching power supply equipment characterized by being switching power supply equipment indicated to claim 3, establishing a load current detection means, and coming to change a time delay over an ON signal to said 1st switching means according to magnitude of the load current.